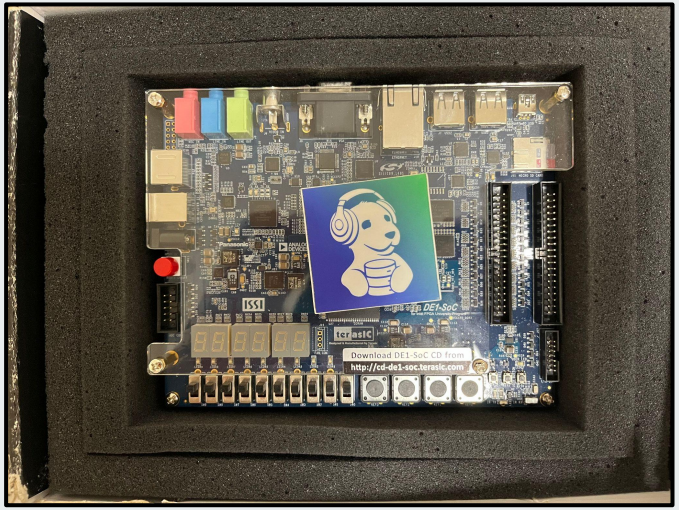
FPGA DJ



Joy He, Oliver MacGregor, Harrison Riley, Joshua Zhou

What we have 📣

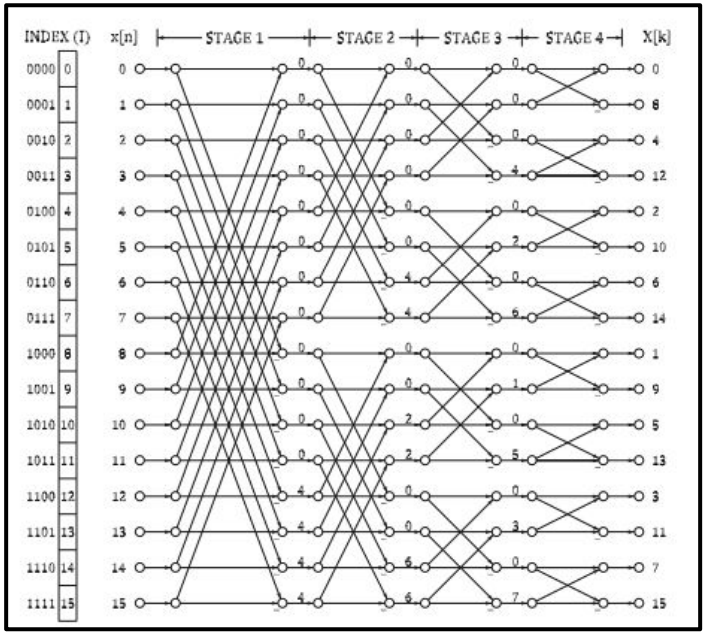
- The FPGA DJ can play two songs simultaneously
- Playback and effects are controlled by the keyboard
- Play/pause, skip around songs, loop songs
- Gain, echo, low pass/high pass filtering, airhorn

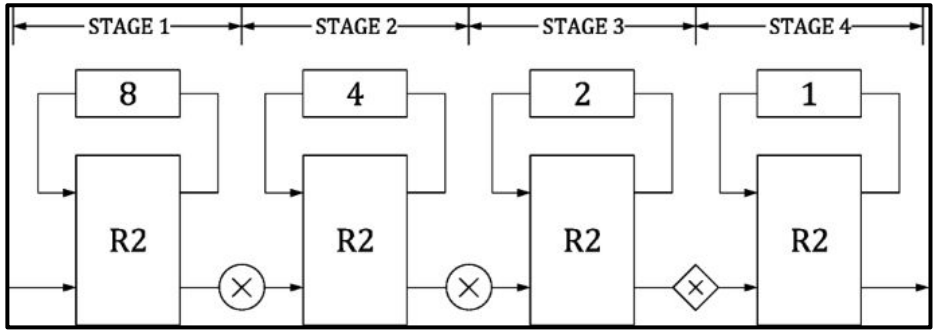
Behind the scenes 🎪

- Hardware FFT & IFFT to apply frequency domain effects
- Audio interface
  - Qsys
  - FIFOs to hold data and signal when codec is busy or free
- Hardware-software interface
  - Device drivers to allow software to write song data and control frequency cutoffs
  - Interrupts sent by hardware to ensure writes from software are timed correctly
- Software logic to read WAV files, processes input from a keyboard, and do some audio processing

Hardware 

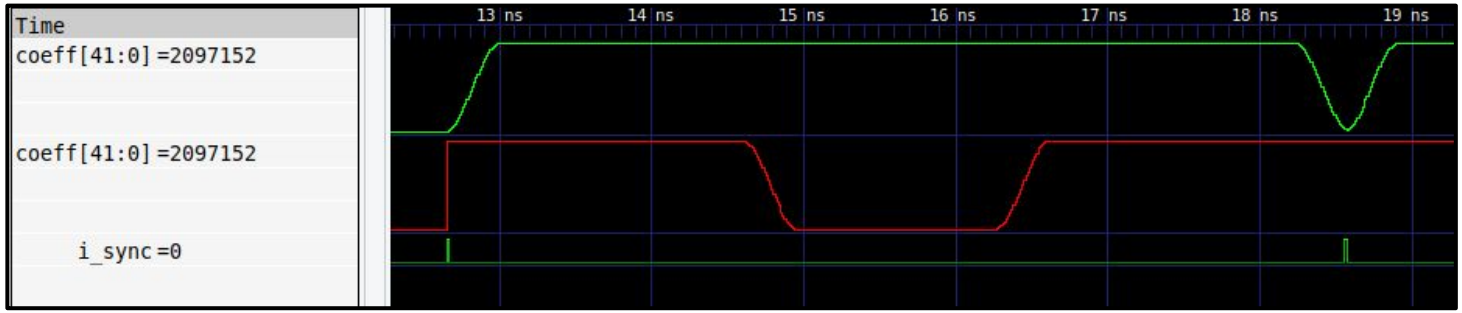
Pipelined FFT/IFFT



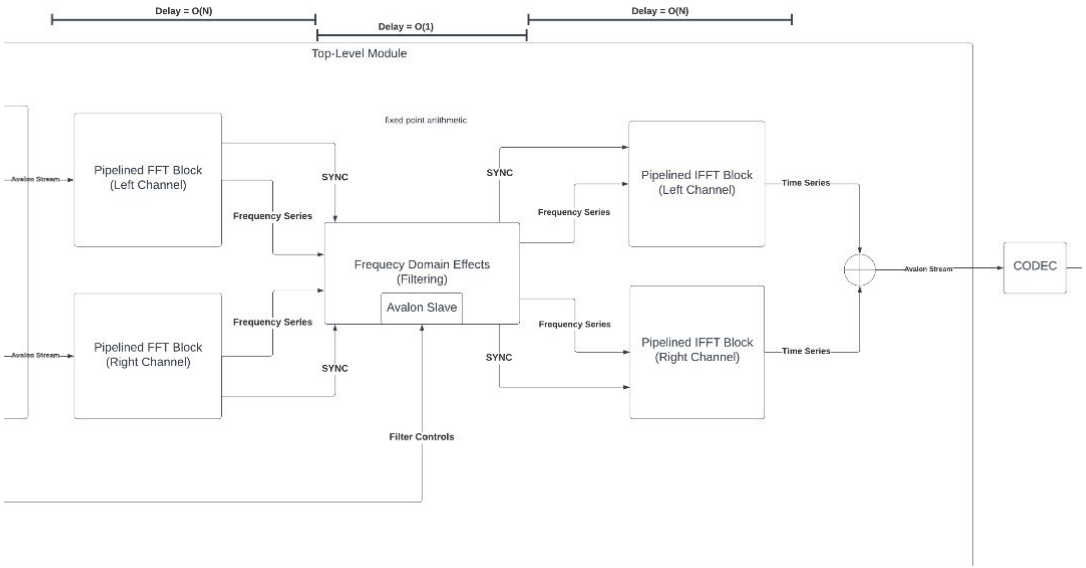


Hardware Effects - Frequency Domain

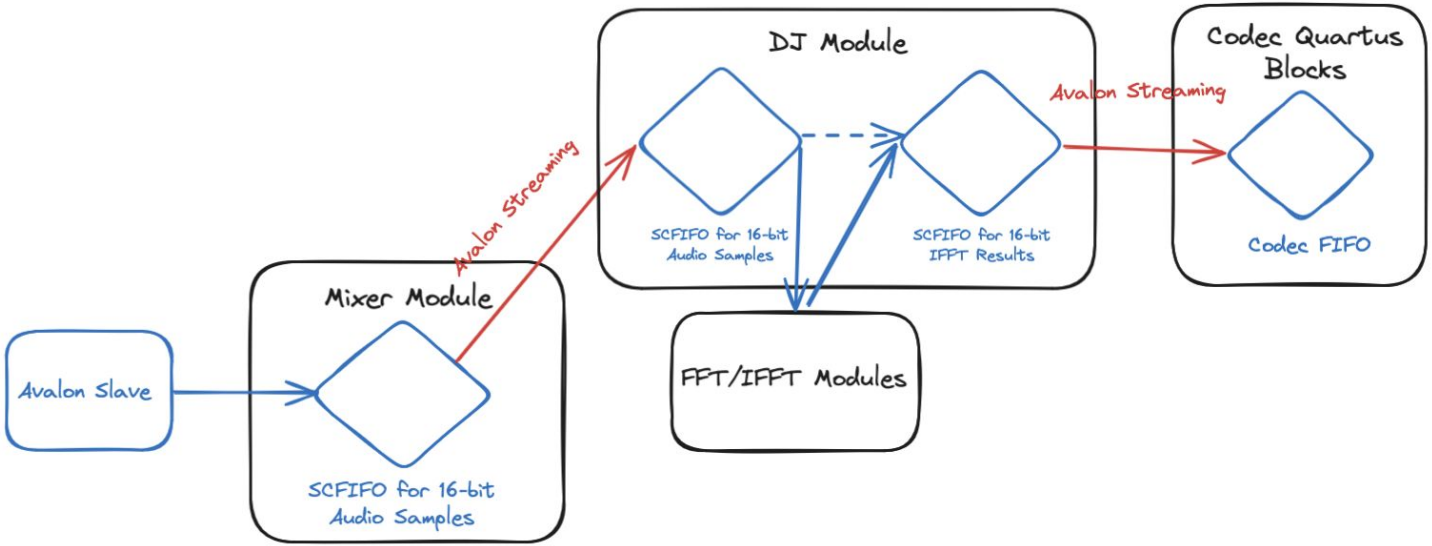
Filtering



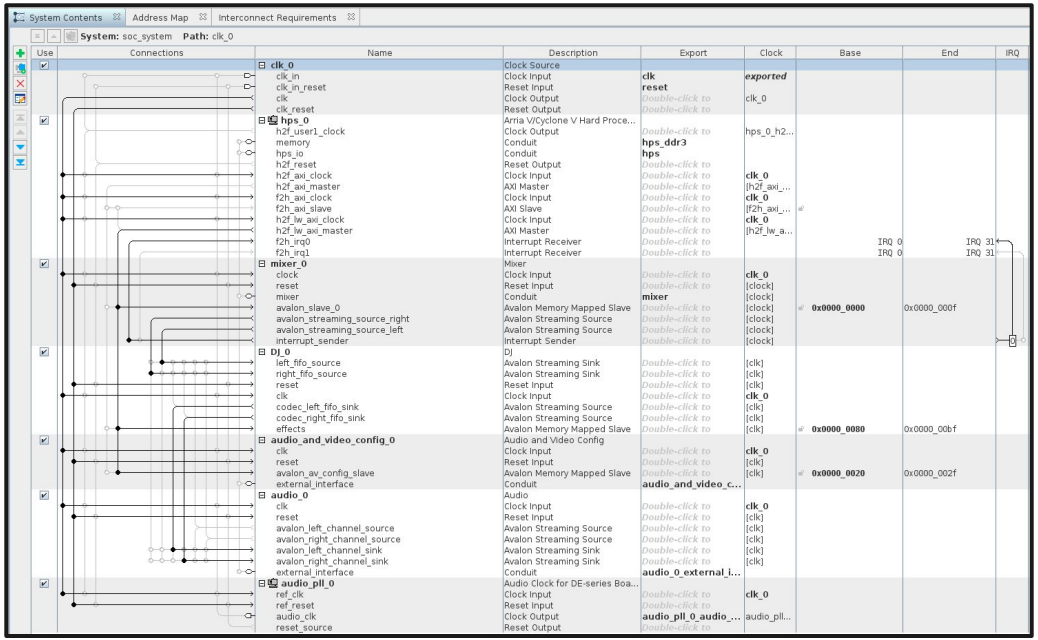
Frequency Domain Effects Hardware Architecture



Audio Interface 🔊

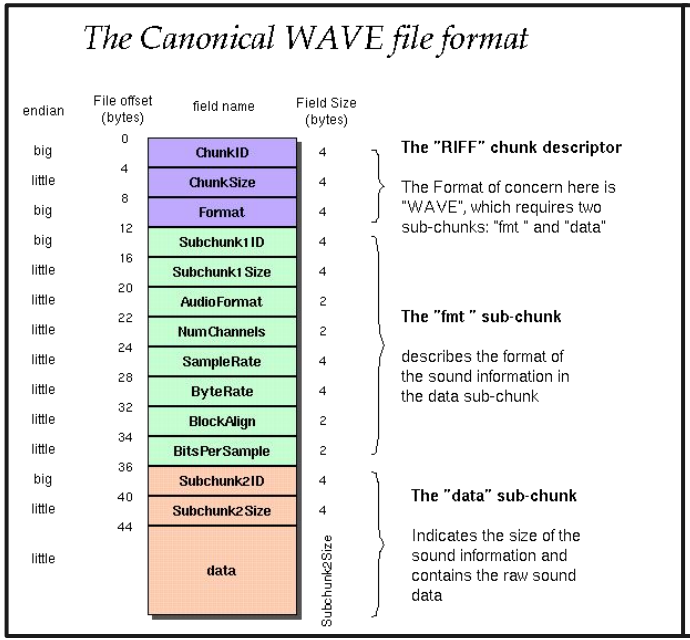


Hardware-Software Interface 🔮



Software 

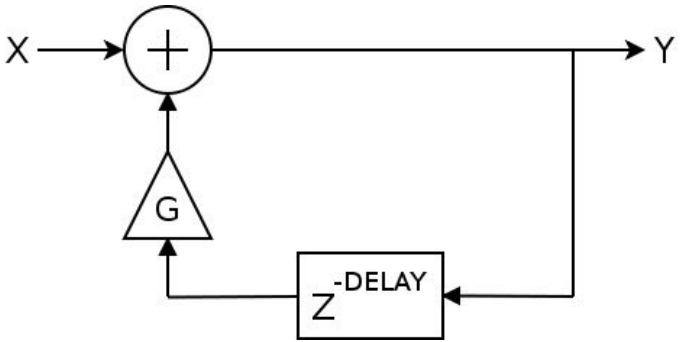
Software 👾



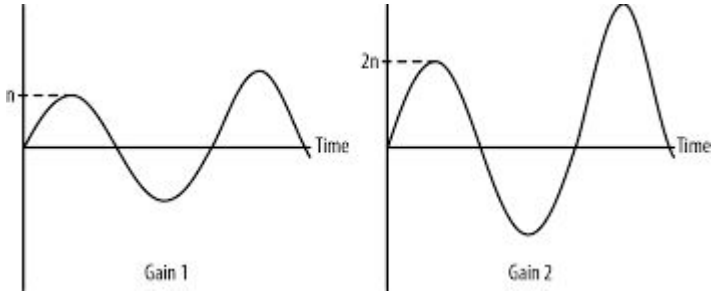

```
int song_ndx;
int do_silent;
float gain;
int do_echo;
int echo_offset;
int do_loop;
uint8_t lpf_cutoff;
uint8_t hpf_cutoff;
```

Software Effects - Time Domain

Echo

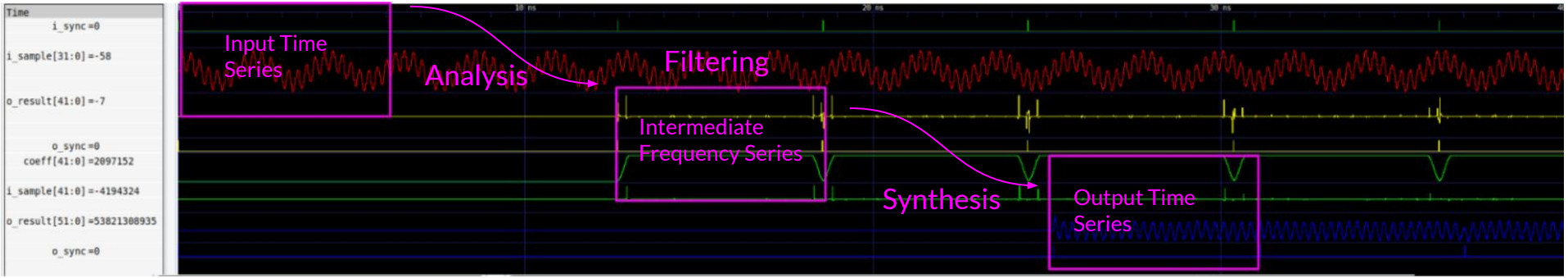


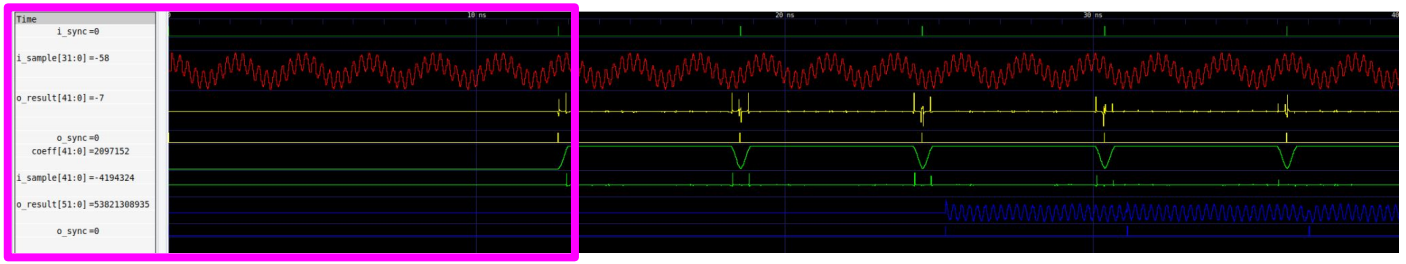
Gain

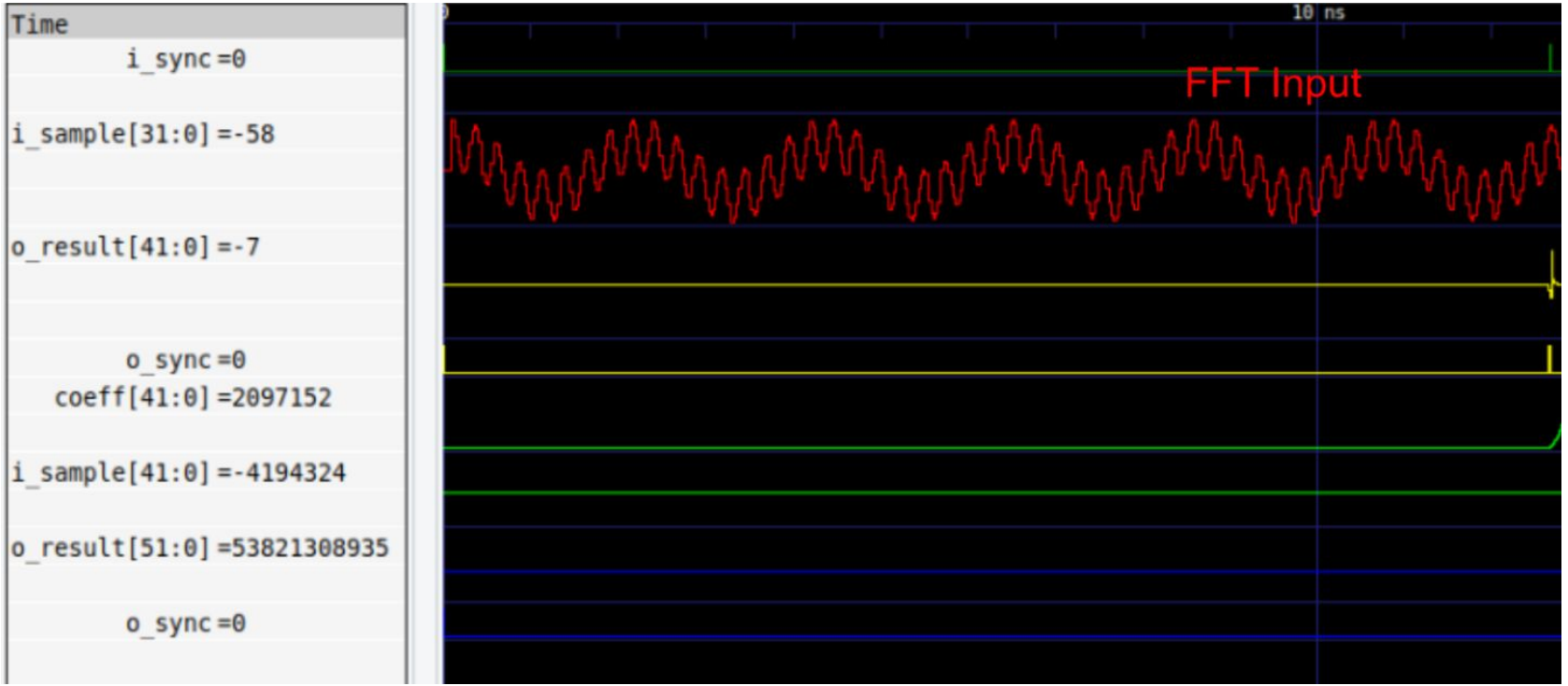


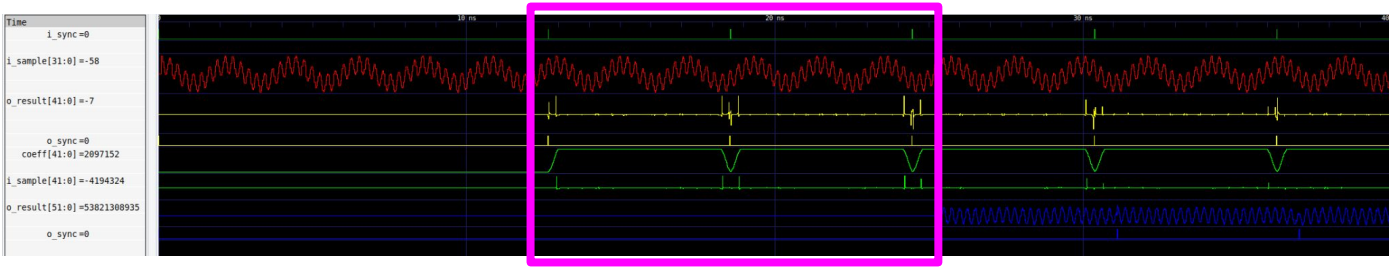
Validation and Testing 🤔

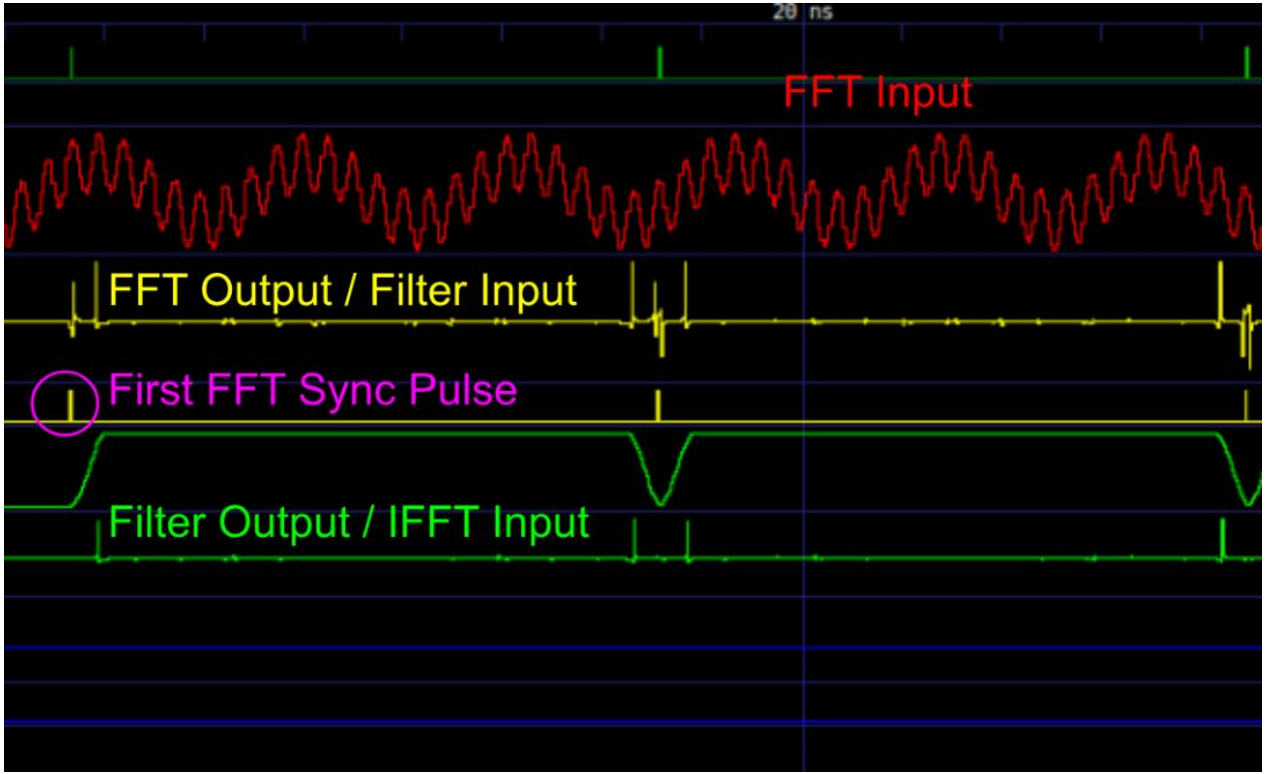
Simple Filtering Test

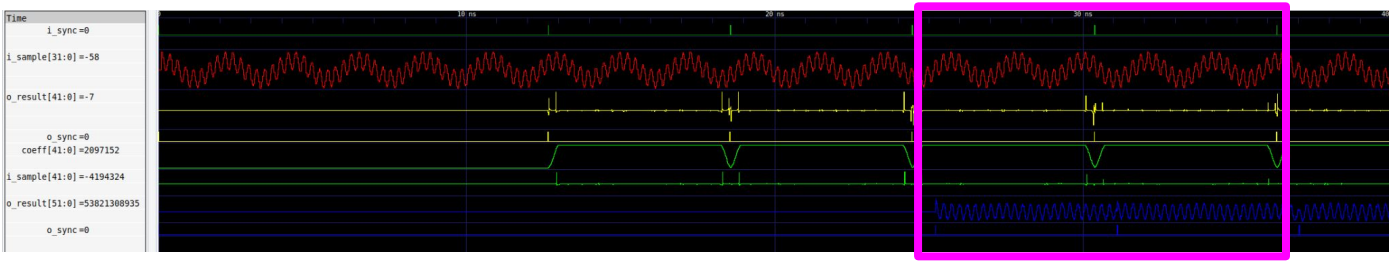


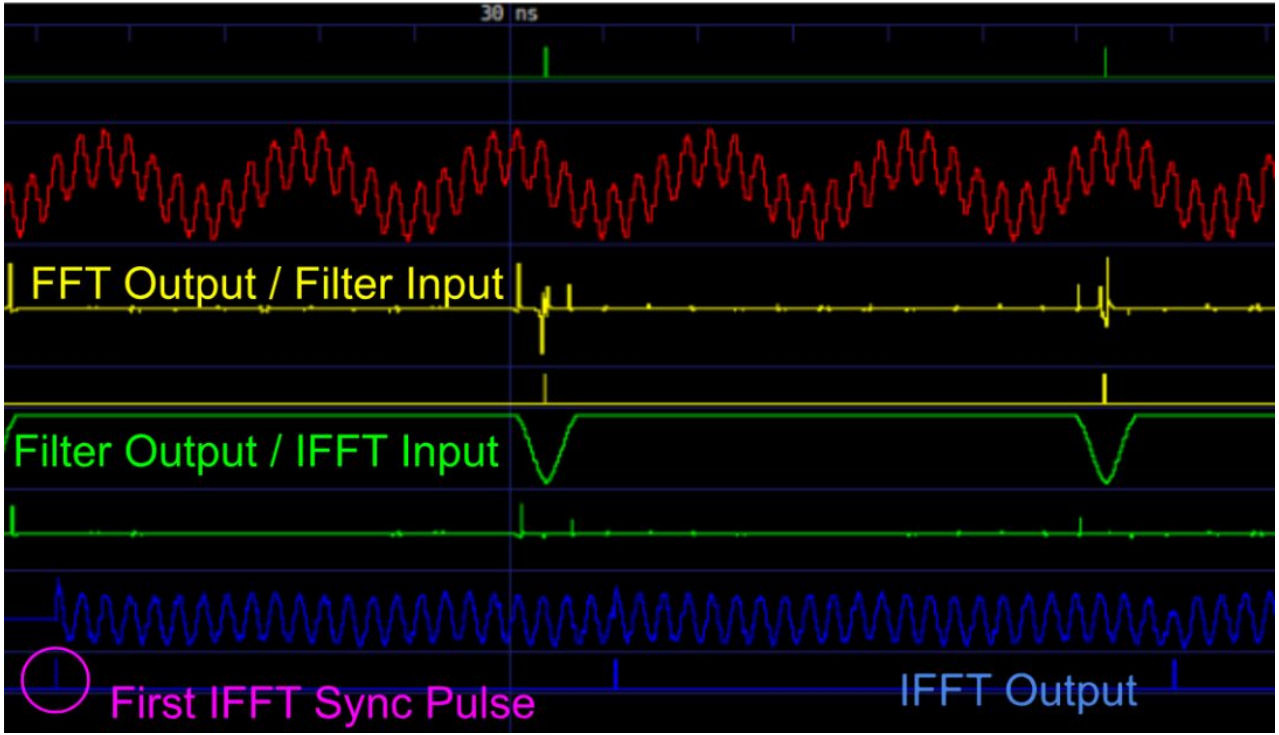

Time
i_sync =0
i_sample[31:0] =-58
o_result[41:0] =-7
o_sync =0
coeff[41:0] =2097152
i_sample[41:0] =-4194324
o_result[51:0] =53821308935
o_sync =0
10 ns
20 ns
30 ns


Time
i_sync =0
i_sample[31:0] =-58
o_result[41:0] =-7
o_sync =0
coeff[41:0] =2097152
i_sample[41:0] =-4194324
o_result[51:0] =53821308935
o_sync =0
10 ns
FFT Input


Time
i_sync=0
i_sample[31:0]=-58
o_result[41:0]=-7
o_sync=0
coeff[41:0]=2097152
i_sample[41:0]=-4194324
o_result[51:0]=53821308935
o_sync=0
10 ns
20 ns
30 ns


20 ns
FFT Input
FFT Output / Filter Input
First FFT Sync Pulse
Filter Output / IFFT Input


Time
i_sync=0
i_sample[31:0]=-58
o_result[41:0]=-7
o_sync=0
coeff[41:0]=2097152
i_sample[41:0]=-4194324
o_result[51:0]=53821308935
o_sync=0
10 ns
20 ns
30 ns


30 ns
FFT Output / Filter Input
Filter Output / IFFT Input
First IFFT Sync Pulse
IFFT Output

Demo


(o _____ o)